

ENSO RESPONSE TO ALTERED CLIMATES

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A DISSERTATION
PRESENTED TO THE FACULTY
OF PRINCETON UNIVERSITY
IN CANDIDACY FOR THE DEGREE
OF DOCTOR OF PHILOSOPHY

RECOMMENDED FOR ACCEPTANCE
BY THE PROGRAM IN
ATMOSPHERIC AND OCEANIC SCIENCES

June 2002

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Abstract

Observed secular changes in the El Niño / Southern Oscillation (ENSO) phenomenon are not well understood; nor are the major differences in ENSO simulations found among state-of-the-art general circulation models of the tropical Pacific. To address these issues, this study advances an efficient numerical model of the ocean-atmosphere system and then uses it to explore the sensitivity of ENSO to changes in the climatological background. The model includes dynamical, statistical, and stochastic components and provides a reasonably good simulation of the observed climatology and interannual variability of the tropical Pacific.

A series of idealized experiments reveals how changes in equatorial and off-equatorial zonal wind stresses, meridional stresses, and radiative forcings affect the tropical climatology. Because coupled feedbacks dominate the time-mean response, perturbed climatologies tend to resemble either an El Niño (with warm sea surface temperatures in the eastern equatorial Pacific, weakened trade winds and flattened thermocline) or a La Niña (with cool sea surface temperatures, enhanced trades and steeper-sloping thermocline).

The study then shows how these altered climates impact the behavior of ENSO, including its amplitude, frequency, spatial structure, mechanism, sensitivity to transient disturbances, and predictability. An analysis of the oceanic mixed layer thermodynamics provides a physical basis for understanding these changes. Results from a more sophisticated ocean-atmosphere model are also presented, and the problem of detecting climate-induced ENSO changes in short stochastic timeseries is discussed.

Acknowledgments

My thanks to George Philander, who shared his many ideas, fostered my independence and brought beauty and clarity to my work. I have always enjoyed his genial personality, and evening soireés at his home were a delight with their musical puzzles and the chance for an impromptu tango in his living room.

Thanks also to Jeff Anderson, who directed my pre-generals research and taught me to be deliberate and thorough. His passion for applied problems and his statistical and dynamical-systems expertise kept me honest and provided essential tools I needed to become a competent scientist.

Kudos to Tony Rosati and Matt Harrison for much encouragement and support over the past few years. Tony carefully read this thesis and offered many great suggestions. Matt kindly configured the hybrid GCM for my use, and contributed numerical codes that inspired Chapter 3.

Many others contributed to this work. Geoff Vallis, Kirk Bryan, and Ants Leetmaa graciously volunteered to read this thesis and provided useful comments. Alexey Fedorov was a sounding board for theoretical ideas. Gabriel Lau, Isaac Held, Steve Griffies, Kevin Hamilton, Bin Wang, Eli Tziperman, and Lisa Goddard gave advice and encouragement at critical times. Interactions with Scott Harper, Giulio Boccaletti, Eli Galanti and Jong-Seong Kug were also helpful. Thanks to Gail Haller and Bea Amend for maintaining an excellent library; to Hans Vahlenkamp and Larry Lewis for computing solutions; to Jim Byrne for his assistance with many interoffice moves; and to the ready-room staff for their cheerful company during lonely weekends and late nights. I gratefully acknowledge NASA and the NSF for their generous fellowship awards, which were expertly administered by Laura Rossi, Anna Valerio, and Johann Callan of the AOS program. Thanks also to the TAO Project and the crew of the good ship Ka’imimoana for showing me the ropes during six unforgettable weeks at sea.

Fond memories from grad school: science/policy adventures in Hokkaido with Tracey Holloway; beers and strategy games with Olivier Pauluis; “Entry 34” parties with Tapio Schneider; biking the mountains of Oregon with Dave Baker. Political discussions with Curtis Deutsch and office-mates Yunqing Zhang, Frederic Vitart, and Irina Marinov. Three rewarding semesters with George Philander, Scott Harper, Barbara Winter, and Meredith Galanter teaching the science of weather and climate to undergraduates.

Thanks to Olly, Eric, Colleen, Alana, Wade, Jon, and Corrinne for dragging me away from work to celebrate life. Thanks to my family for always believing in me.

Above all, thanks to my wife Gayle for her infinite patience. Only with her bright smile, warm heart, sharp mind, and giving nature could I complete such a large project. From early-morning Linux hints to afternoon pep talks and late-night supper deliveries, she has been the most versatile and helpful companion on this journey.

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